

Executive Summary

Chapter 1: Introduction

The purpose of the Abalone Recovery and Management Plan (ARMP) is to provide a cohesive framework for the recovery of depleted stocks in central and southern California, and for the management of the existing northern California fishery and any future fisheries. A recovery and management plan is needed to prevent further population declines in southern California and ensure the sustainability of current and future fisheries.

The interim recovery goals are to reverse declines in populations by stabilizing stocks, and to establish self-sustaining populations range-wide. The long-term recovery goal is to attain resource levels that can sustain a fishery.

The interim management goal is to institute an adaptive plan that employs a precautionary approach, given limited funding and data collection, to manage the existing red abalone fishery in northern California. The long-term management goal is to implement tag-based, zonal management that allows more responsive regulatory actions.

Chapter 2: Description of Stocks

Seven species of abalone, *Haliotis* spp., are found in California: red, pink, green, black, white, pinto, and flat. Most are found in the coastal waters intertidally to 60 meters (197 ft) in depth. Abalones are found in boulder and rock habitat, and are usually associated with kelp forests. They are long-lived, slow-growing species with high fecundity (number of eggs and sperm produced), but highly variable recruitment. Red abalone require at least 10 to 14 years to reach the minimum recreational (or sport) legal size.

Abalones broadcast their eggs and sperm into the water. A minimum density of spawners is essential for successful broadcast spawning. When population densities drop below a critical threshold, reproduction failure can occur, and if protracted, can lead to local extinction.

The sources of abalone mortality include natural and human causes. Natural mortality occurs primarily from predators such as fishes, invertebrates, and sea otters; disease, which has severely affected southern California abalones; and environmental factors which affect the food supply. Environmental factors include El Niño events and storms. Human causes of mortality include fishing, pollution, and impacts to habitat.

The status of California's abalones ranges from near extinction (white abalone) to fairly robust populations (the northern red abalone). Northern California red abalone populations have supported a viable fishery, but recent studies have revealed four trends which are cause for concern: a concentration of fishery effort and increased take, evidence of poor recruitment, declines in deep-water stocks, and serial depletion. In central and southern California the overall trend in red abalone abundance is one of decline. Pink, green, black, and white abalones were once common species in southern California, but are now rare. White abalone is listed as an endangered species under the federal Endangered Species Act, and black abalone is a candidate for listing. Flat and pinto abalones have always been uncommon in California.

Chapter 3: History and Socio-economics of the Fishery

Five species of abalone have been taken as part of California's commercial and recreational abalone fisheries: red, pink, green, black, and white.

Regulation of the commercial fishery began in 1901. This fishery occurred almost exclusively in central and southern California. Between 1942 and 1996, the trends in total commercial landings for all abalone species were marked by four distinct stages: A) increased landings between 1942 and 1951, B) relatively stable landings between 1952 and 1968, C) a rapid decline in landings between 1969 and 1982, and D) a gradual and steady decline between 1983 and 1996. When commercial landings are separated by individual species, a serial depletion of the fishery by species becomes evident. As the more desirable abalone populations experienced stock collapse, the fishery shifted to other species. Similarly, the historical commercial catch records show a shift from mainland and nearshore island locations to more remote locations as stocks were fished out at the sites easiest to access. The large-scale decline followed a period of compaction of the fishery as central California stocks were usurped by expanding populations of sea otters, sport and commercial fishing pressure, disease, and pollution. Commercial landing statistics provide the best fishery-dependent record of magnitude of decline resulting from various cumulative impacts. The economic value of the California commercial abalone fishery prior to its closure in 1997 was calculated at \$2,515,467 from the ex-vessel value of abalone landings for 1995. This value is an underestimate of the actual value of the fishery.

Regulation of the recreational fishery began in 1911. Catch and effort data for the southern California recreational fishery are limited to that available from commercial passenger diving boat logbooks. These data revealed that green and pink abalones predominated in recreational catches before 1983, with smaller numbers of red, black, and white abalones being taken. From 1986 to 1990 the proportion of pink abalone declined, leaving green abalone as the predominant species. The number of red abalone increased in the landings, while the black and white abalones disappeared. Due to stock collapse, the entire recreational abalone fishery was closed south of San Francisco by 1997. At the close of the fishery, the estimated value for the southern California sport abalone fishery was \$3,450,472.

The sport-only abalone fishery in northern California was created in 1949 and still exists. This fishery was restricted to breath-hold diving (underwater breathing apparatus was and still is prohibited) in 1953. There was an estimated average take of 685,000 abalones from 235,000 trips (effort days) during 1983 to 1989. From 1998 to 2000 abalone permit sales averaged 38,276. Preliminary abalone take and effort estimates are 728,000 abalone from 202,000 trips (derived from incomplete abalone report card returns for 2000). The estimated fishery value, when adjusted for inflation via the consumer price index, and reduced by the decline in effort, stands at \$11.6 million.

Abalone poaching has been a serious concern in California for decades and continues to have a major impact on abalone stocks.

Chapter 4: Legal Framework

The California Department of Fish and Game has responsibility for the conservation, protection, and management of abalone under the direction of the Fish and Game Commission. Regulation changes and plan amendments regarding abalone are made by the Fish and Game Commission. Fish and Game Code §5522 requires that a draft ARMP be developed by the Department and submitted to the Commission prior to January 2003, and describes some key components of the ARMP. Because abalone management is affected by sea otter predation, the ARMP must comply with two federal laws: the Marine Mammal Protection Act and the Endangered Species Act. Amendment of the ARMP will occur if there are changes to management or recovery goals, objectives, and/or criteria, changes to the species addressed by the ARMP, or amendments to any procedures required by the ARMP.

Chapter 5: Overview for Recovery and Management Approach

Recovery of at-risk abalone species and management of abalone fisheries are separate but continuous and complementary processes in the ARMP. The ultimate recovery goal is to move species from a perilous condition to a sustainable one, with surplus stocks available for fishing; the ultimate management goal is to maintain sustainable fisheries under a long-term management plan that can be adapted to changes in the environment. The primary criteria used to evaluate the achievement of both recovery and management goals involve estimates of recruitment and population abundance (measured by density). Criteria used in the ARMP are applied to index sites in key areas.

Because several species in central and southern California face a high risk of extinction, during the first seven years of ARMP implementation the majority of research will be directed towards recovery. Efforts will initially focus on assessing the relative risk of extinction, identifying where remnant populations remain, developing recovery techniques, and using these techniques to rebuild populations of at-risk species to self-sustaining levels.

The management plan establishes regulatory guidelines for determining allowable take levels and for closure and re-opening of fisheries. During the first 7 years of ARMP implementation, management of the existing fishery will occur under a precautionary interim plan that sets a total allowable catch level and uses established criteria to guide regulatory change. Ultimately, if additional support is developed, management should change to a long-term plan that uses zonal management and allocates take through abalone tags. The long-term plan requires increased assessment and enforcement, but is more responsive to stock changes and can therefore be less precautionary.

Marine protected areas (MPAs) that provide refuge from take for all species play an important role in the ARMP for both recovery and management. MPAs are currently being considered under the Marine Life Protection Act and are needed as soon as possible for implementing abalone recovery.

Chapter 6: Recovery Plan

Five abalone species formerly supported valuable commercial and recreational fisheries in southern and central California. Today, four of those species (pink, green, black, and white) are at very low population levels. White abalone is listed as an endangered species under the federal Endangered Species Act. Black abalone are a candidate species for listing. While not at risk of extinction, red abalone's range has been severely decreased.

The long-term goal of abalone recovery in southern and central California is to rebuild populations of each species to levels where they may once again support fisheries. Before that goal can be addressed, two interim goals must be achieved. First, populations must be brought to levels which are no longer at risk of extinction. This goal may require human intervention involving culturing abalone, moving individual abalone closer together in the wild, and protecting habitat through the use of MPAs. Second, populations will need to be rebuilt, where feasible, throughout historic ranges to establish population stability. This will involve continued protection for all abalone species, and MPAs specifically designed to encourage reproduction.

The stepwise general plan for the rebuilding of all species of abalone lists 10 tasks for recovery which are broken into three activities:

- Assessment of habitat and stock
- Research (enhancement activities)
- Research (genetics and disease)

The first activity encompasses three tasks:

- Exploratory surveys
- Detailed surveys of known abalone habitat
- Assessment for recovery

The second activity includes five tasks:

- Develop or support existing culture programs
- Feasibility study for out-planting
- Feasibility studies for aggregation/translocation
- Aggregation or translocation
- Out-planting

The last activity has two tasks:

- Genetics: Determine if there are sub-populations
- Evaluation of resistance to Withering Syndrome

Not all tasks will be applied to each species. For example, the last task (Task 11 - Involvement in the Federal white abalone recovery team), is a specific task to white

abalone recovery and does not apply to the other species. Specific approaches for recovery of each species are described, as well as how the tasks will be applied.

Chapter 7: Fishery Management Plan

The management plan is presented in two phases: an interim plan, which uses a precautionary approach based upon limited data collection, and a long-term plan, which will allow for more refined and responsive management, but requires more extensive data collection. The interim plan will become effective immediately upon plan adoption.

The interim management plan applies to the northern red abalone sport fishery until the long-term plan is implemented. The interim plan allows management using available data, taking a precautionary approach. The plan establishes a fishery-wide total allowable catch (TAC) of 400,000 abalone, which can be adjusted based on overall stock conditions. Formal use of a TAC will require development of implementation regulations under the Administrative Procedures Act. The plan also allows for closure of depleted high-impact sites based on local stock conditions. A set of specific criteria guides the management decision-making process. Criteria are measured at index sites in the fishery range.

The long-term plan will use many of the elements of the interim plan including criteria and TAC. However, to address the limitations of the interim plan, the long-term management plan may also establish management zones and develop new management tools such as abalone tags or other methods to improve control over local take. These improvements may require increased survey effort. With increased information, the long-term plan can be less precautionary than the interim plan. Implementation of the long-term plan is not expected before 2009 and may require additional support.

Currently, the central and southern California abalone fisheries are closed due to stock collapse that resulted from both human and natural factors. When recovery criteria are met and stock levels meet the management criteria for sustainable fishing densities, a planning process for fishery re-opening may begin. Each species will be individually evaluated for re-opening.

Alternatives to the management plan modify either the overall recovery and management approach or individual components of the recovery and management plan. Plan alternatives are presented which include allowing limited fishing during the recovery phase, increasing the TAC maximum, completely closing the northern fishery, increasing the minimum viable population, and incorporating estimates of illegal take into the TAC.

Chapter 8: Abalone Enforcement Activities

Enforcement includes staff from the Marine Region, coastal regions and Special Operations Unit of the Department. Enforcement personnel use a variety of methods to assist in tracking illegal take of abalone including patrols of tidal areas by uniformed wardens as well as aircraft and boat patrols. In addition, abalone checkpoints are established several times during the season to educate the public, check compliance with laws and detect violations. Undercover wardens are used by the Department to discretely observe persons that have been reported as violators. This unit has been

very successful at tracking illegal take of abalone for commercial purposes. Enforcement also provides input for regulatory proposals recommended by biologists. Officers also inform and educate constituents about regulations that protect recovering and managed stocks (Section 9.1.4). The CalTIP program has been very helpful with enforcement efforts related to abalone. With limited personnel available, wardens depend on the public to report violations they observe.

Chapter 9: Implementation (Activities, Time Lines, and Costs)

Management and recovery will be implemented through several types of activities: assessment, research, plan development, regulatory process, and enforcement. Assessment will focus on collecting and analyzing management and recovery related data, as well as improving data assessment methods/resources. Research will include studies on genetics, disease, the feasibility of out-planting and translocation/aggregation, and the development of new research methods. The plan development and regulatory process involves reviewing management and recovery reports with constituents, and recommending changes to regulations and ARMP amendments. Enforcement will concentrate on ensuring compliance with regulations, and collaborating with scientific staff in conducting research from enforcement vessels.

A seven-year timeline (2003 to 2009) has been developed for the implementation of recovery and management activities. These activities will alternate annually to minimize cost by allowing sharing of funding, resources, and staff.

Costs for recovery and management activities will require a yearly expenditure of \$1,480,000 of which \$580,000 will be directed to enforcement. Funds will be acquired from the Fish and Game Preservation fund, which consists of non-dedicated and dedicated accounts. Dedicated monies reserved for expenditure on abalone are generated from the abalone report card, former commercial landing taxes, and violation fines.

Table of Contents

Executive Summary	i
Table of Contents	vii
List of Figures	vi
List of Tables	xi
List of Acronyms and Abbreviations	xv
List of Appendices	xvi
Acknowledgments	xviii
List of Preparers	xix
 Chapter 1. Introduction	 1-1
1.1 Location of the Project Area	1-1
1.2 Purpose and Need for Action	1-1
1.3 Specific Goals of the Plan	1-2
 Chapter 2. Description of Stocks	 2-1
2.1 Biological Information	2-1
2.1.1 Geographic Range and Distribution	2-1
2.1.2 Reproduction	2-1
2.1.2.1 Maturation	2-1
2.1.2.2 Spawning and Fecundity	2-1
2.1.3 Recruitment	2-2
2.1.4 Genetics	2-3
2.1.5 Early Life History	2-4
2.1.5.1 Larval Development	2-4
2.1.5.2 Larval Dispersal	2-4
2.1.5.3 Post-larval Development	2-4
2.1.6 Age and Growth	2-4
2.1.7 Food	2-5
2.1.8 Movement	2-6
2.1.9 Mortality	2-6
2.1.9.1 Predation	2-6
2.1.9.2 Diseases and Parasites	2-7
2.1.9.3 Environmental Factors	2-9
2.1.10 Competition	2-10
2.1.11 Community Associates of Abalone	2-10
2.1.12 Abalone Habitat	2-12
2.1.12.1 Habitat Types	2-12
2.1.12.2 Latitudinal Habitat Variation	2-13
2.2 Status of Abalone Stocks	2-13
2.2.1 Red Abalone	2-14
2.2.1.1 Northern California Stocks	2-14
2.2.1.2 Central and Southern California Stocks	2-15
2.2.2 Pink Abalone	2-16

2.2.3 Green Abalone	2-16
2.2.4 Black Abalone	2-16
2.2.5 White Abalone	2-18
2.2.6 Pinto Abalone	2-20
2.2.7 Flat Abalone	2-20
Chapter 3. History and Socio-economics of the Fishery	3-1
3.1 History	3-1
3.1.1 History of the Fishery	3-1
3.1.1.1 Commercial	3-1
3.1.1.2 Recreational	3-5
3.2 Socio-economic Characteristics of the Fishery	3-8
3.2.1 Commercial Sector	3-8
3.2.2 Recreational Sector	3-8
3.2.3 Non-consumptive Use	3-9
3.2.4 Illegal Use: Poaching	3-9
Chapter 4. Legal Framework	4-1
4.1 Authority and Responsibility	4-1
4.1.1 California Department of Fish and Game	4-1
4.1.2 Fish and Game Commission	4-1
4.2 California State Law	4-1
4.2.1 Legislation Mandating the ARMP	4-1
4.2.2 California Environmental Quality Act (CEQA)	4-3
4.2.3 Marine Life Management Act (MLMA)	4-3
4.2.4 Marine Life Protection Act (MLPA)	4-3
4.3 Federal Law	4-3
4.4 Process of Plan Review and Amendment	4-4
Chapter 5. Overview of Recovery and Management in the ARMP	5-1
Chapter 6. Recovery	6-1
6.1 Goals	6-1
6.2 Criteria for Evaluation of Resource Recovery	6-1
6.2.1 Size Distribution-Based Assessment (Timed Surveys)	6-1
6.2.1.1 Criterion 1 - Broad Size Distribution Over the Former Abalone Range	6-2
6.2.2 Density-Based Criteria	6-5
6.2.2.1 Criterion 2 - First Density Level (2,000 ab/ha)	6-5
6.2.2.2 Criterion 3 - Fishery Density Level (6,600 ab/ha)	6-5
6.3 Fishery Consideration	6-5
6.4 Recovery Activities	6-6
6.4.1 Periodic Assessment of Abalone and Essential Habitat	6-6
6.4.1.1 Assessment for Criterion 1	6-6
6.4.1.2 Assessment for Criterion 2	6-7

6.4.1.3 Assessment for Criterion 3	6-7
6.4.2 Enhancement Activities	6-7
6.4.2.1 Translocation or Aggregation of Adult Stocks	6-7
6.4.2.2 Larval Out-planting	6-8
6.4.2.3 Captive Breeding to Obtain Large Individuals for Out-planting	6-8
6.4.2.4 Establishing Marine Protected Areas	6-8
6.4.3 Genetics and Disease Research	6-9
6.4.3.1 Genetics Research	6-9
6.4.3.2 Disease Research	6-10
6.5 Challenges to Abalone Recovery	6-10
6.5.1 Disease	6-11
6.5.2 Sea Otters	6-11
6.5.3 Other Challenges to Abalone Recovery	6-12
6.6 Recovery Approach	6-12
6.6.1 The General Recovery Plan	6-12
6.6.1.1 Assessment of Habitat and Stock	6-12
6.6.1.2 Research (Enhancement Activities)	6-14
6.6.1.3 Research (Genetics and Disease Studies)	6-16
6.6.2 Recovery Plan Elements for Individual Species	6-17
6.6.2.1 Red Abalone	6-17
6.6.2.2 Pink Abalone	6-19
6.6.2.3 Green Abalone	6-21
6.6.2.4 Black Abalone	6-23
6.6.2.5 White Abalone	6-25
6.6.2.6 Pinto Abalone and Flat Abalone	6-26
6.7 Timelines	6-27
6.8 Alternatives Approaches to Recovery	6-28
6.8.1 Alternative 1 - Listing of Species that Fail to Recover	6-28
Chapter 7. Abalone Management	7-1
7.1 Fishery Management Plan	7-1
7.1.1 Management Measures	7-1
7.1.1.1 Species-specific Considerations for Management	7-1
7.1.1.2 Gear Restrictions	7-1
7.1.1.3 Marine Protected Areas	7-1
7.1.1.4 Size Limits	7-2
7.1.1.5 Seasonal Closures	7-2
7.1.1.6 Catch Limits	7-2
7.1.1.7 Abalone Take Reporting System	7-2
7.1.2 Interim Management Plan	7-3
7.1.2.1 Criteria for Evaluating Stocks	7-3
7.1.2.2 Total Allowable Catch	7-5
7.1.2.3 Regulation of Actual Catch Levels	7-7

7.1.2.4	Site Closure	7-8
7.1.2.5	Interim Management Regulatory Time Frame	7-9
7.1.2.6	Limitations of the Interim Management Plan	7-11
7.1.2.7	Scenario for Reduced Fishery Monitoring	7-12
7.1.3	Long-term Management Plan	7-12
7.1.3.1	Zonal Management	7-12
7.1.3.2	New Management Tools	7-13
7.1.3.3	Data Sources and Refinements	7-13
7.1.3.4	Closing and Re-opening Fisheries	7-14
7.1.3.5	Long-term Plan Timeline	7-14
7.1.4	Re-opening of Recovered Fisheries	7-14
7.1.4.1	Planning Process for Fishery Re-opening	7-15
7.1.4.2	Application of the Long-term Plan to Re-opened Fisheries	7-15
7.1.4.3	Management Regions	7-16
7.2	Research Protocols - Managing a Sustainable Fishery	7-17
7.2.1	Northern Management	7-17
7.2.1.1	Fishery-Dependent Data	7-18
7.2.1.2	Fishery-Independent Data	7-19
7.2.2	Southern Management	7-20
7.2.3	Future Research	7-20
7.2.4	Summary of Past and Current Fishery-Dependent Monitoring and Fishery-Independent Assessment	7-21
7.2.4.1	Fishery-Dependent Monitoring	7-21
7.2.4.2	Fishery-Independent Assessment	7-22
7.2.5	Socio-economic Data Needs	7-23
7.2.6	Collaborative Research Efforts	7-23
7.3	Management Alternatives	7-23
7.3.1	Alternative 1 (applies to recovery areas within the moratorium area): Limited Fishing Without Full Achievement of Criteria 3.	7-23
7.3.2	Alternative 2 (applies to recovery areas within the moratorium area): Limited Fishing at Reduced Criterion 3 Density Level and Establishment of New Criterion 4	7-24
7.3.3	Alternative 3 (applies to recovery areas within the moratorium area): Opening a Limited Fishery for Red Abalone in Areas of Imminent Otter Reoccupation Without Full Achievement of Criterion 3	7-26
7.3.4	Alternative 4 (applies to recovery areas within the moratorium area): Immediately Open Closed Areas to Take of Red Abalone	7-26
7.3.5	Alternative 5: Lower the TAC by the Estimated Amount of Illegal Take	7-27

7.3.6 Alternative 6: Immediate and Complete Closure of the Remaining Red Abalone Fishery	7-27
7.3.7 Alternative 7: Allows Future TAC Increases Above Current Maximum Increase of 25%	7-27
Chapter 8. Abalone Enforcement Activities	8-1
8.1 Overview	8-1
8.2 Methods Used for Abalone Regulation Enforcement by Wardens	8-1
8.3 Collaboration Between Management and Enforcement	8-2
8.4 Enforcement Needs	8-3
8.5 Community Outreach	8-3
Chapter 9. Implementation (Activities, Timelines, and Cost)	9-1
9.1 Activities	9-1
9.1.1 Assessment	9-1
9.1.2 Research	9-1
9.1.3 Plan Development and Regulatory Process	9-1
9.1.4 Enforcement	9-2
9.2 Time Lines	9-2
9.2.1 Interim Recovery (2003 to 2009)	9-2
9.2.2 Interim Management (2003 to 2009)	9-3
9.2.3 Interim Enforcement (2003 to 2009)	9-3
9.3 Costs	9-4
9.3.1 Interim Costs (2003 to 2009)	9-4
9.3.1.1 Recovery and Management Costs	9-4
9.3.1.2 Enforcement Costs	9-7
9.3.2 Long-term Costs	9-8
9.3.3 Funding Sources	9-8
Appendices	
Literature Cited	References-1
Personal Communications	References-10
Glossary	References-11

List of Figures

1-1	Map of California with project regions, islands, and points used in text	1-3
1-2	The geographic distribution of abalone species in California	1-4
2-1	Emergent red abalone surveys - Van Damme State Park 1986-1999	2-17
2-2	Red abalone catch, density, and number per hour from northern, central, and southern California mainland, and four Channel Islands	2-19
3-1	Commercial landings (metric tons) of California abalone fishery combined, and by red, pink, green, black, and white abalones	3-2
3-2	Landings for red, pink, green, black, and white abalones	3-6
5-1	Conceptual approach for recovery and management under the ARMP	5-3
6-1	The flow chart of the recovery approach	6-3
6-2	Newly-established MPAs in the Channel Islands National Marine Sanctuary .	6-10
7-1	Northern California recreational abalone fishery creel survey sites	7-10
7-2	The flow chart of the recovery approach revised to reflect a limited fishing alternative	7-25

List of Tables

2-1	Size and estimated age of maturity of California abalones	2-2
2-2	Biological information summary	2-3
2-3	Growth parameters of California abalones summary	2-5
2-4	Red abalone population survey at Van Damme, Fort Ross and Salt Point State Parks, 1986-2000	2-18
6-1	Interim and long-term abundance and depleted areas as criteria for recovery	6-4
6-2	List of recovery activities with field time required	6-13
6-3	Key locations for recovery of red abalone in southern California	6-18
6-4	Key locations for recovery of pink abalone in southern California	6-20
6-5	Key locations for recovery of green abalone in southern California	6-22
6-6	Key locations for recovery of black abalone in southern California	6-24
6-7	Key locations for recovery of white abalone in southern California	6-26
6-8	Key locations for recovery of pinto and flat abalones in southern California . .	6-27
6-9	Estimates for the amount of time for recovery of five species of abalone in southern California	6-28
7-1	Abalone survey summaries, 1999-2000	7-4
7-2	Total Allowable Catch adjustment decision table using established criteria	7-6
7-3	Projected changes (percent) in the baseline TAC (400,000 abalone) with various combinations of daily and annual limits	7-8
7-4	Site closure decision table using established criteria	7-11
9-1	Timeline of recovery activities for 2003 to 2009	9-5
9-2	Timeline of interim management activities for 2003 to 2009	9-6

9-3	Summary of costs and funding sources for implementation averaged over 2003 to 2009	9-7
-----	---	-----

List of Acronyms and Abbreviations

ab/ha - abalone per hectare
APA - Administrative Procedure Act
ARMP - Abalone Recovery and Management Plan
ARPA - Abalone Restoration and Preservation Account
CalTIP - California "Turn in Poachers" program
CCR Title 14 - California Code of Regulations -Title 14
CDFG - California Department of Fish and Game
CEQA - California Environmental Quality Act
CIMRI - Channel Islands Marine Research Institute
CINP - Channel Islands National Park
CPDB - Commercial passenger diving boat
CPUE - Catch-per-unit-of-effort
DFG - Department of Fish and Game
EFI - Essential Fisheries Information
ENSO - El Niño/Southern Oscillation
ESA - Endangered Species Act
FGC - Fish and Game Code
FMP - Fishery Management Plan
GIS - Geographical Information System
GPS - Global Positioning System
ha - Hectare
MLMA - Marine Life Management Act
MLPA - Marine Life Protection Act
MMPA - Marine Mammal Protection Act
MPA - Marine Protected Area
MVP - Minimum Viable Population
NMFS - National Marine Fisheries Service
PISCO - Partnership for Interdisciplinary Studies of Coastal Oceans
PY - Personnel Year
RAAC - Recreational Abalone Advisory Committee
RMLS - Recreational Minimum Legal Size
ROV - Remotely-operated Vehicle
SOU - Special Operations Unit
TAC - Total Allowable Catch
USFWS - United States Fish and Wildlife Service
WLP - Wildlife Protection
WS - Withering Syndrome

List of Appendices

Appendix A. Historical Summary of Laws and Regulations Governing the Abalone Fishery in California	A-1
Appendix B. Excerpts from Legal Documents Relating to Abalone	B-1
Appendix C. Location of the Requirements and Items Suggested for Inclusion in the ARMP by Fish and Game Code §5522(a) and (b).	C-1
Appendix D. Maps of Historical Commercial and Recreational Abalone Fishing by Fishing Blocks	D-1
Appendix E. Survey Methods	E-1
Appendix F. Constituent Involvement, Public and Peer Review Process	F-1
Appendix G. Public Input	G-1

Acknowledgments

We would like to specially acknowledge the late Dr. Mia Tegner, of Scripps Institution of Oceanography, who was a valued colleague, friend, and mentor to the Abalone Team. She spent years working on problems associated with the kelp forest community, and wrote numerous scientific papers concerned with abalones. Dr. Tegner was instrumental in the development of the Abalone Recovery and Management Plan legislation.

Members of several committees and a panel also contributed valuable input to the preparation of the ARMP, and provided a broad perspective. Each panel member considered a large body of information in preparation for workshops. In addition, we wish to acknowledge participation of the members of the Director's Abalone Advisory Committee (DAAC) and Recreational Abalone Advisory Committee (RAAC). We appreciate those efforts and the suggestions and assistance in the preparation of the plan. The members, and affiliation, were (in alphabetical order):

Ben Beede - The Cultured Abalone (Panel); Steve Benevides, recreational diver, RAAC member (Panel); Ron Burton, Scripps Institution of Oceanography (Panel); John Butler, National Marine Fisheries Service, Southwest Fisheries Science Center (Panel alternate); Stephen Campi, recreational diver, RAAC member (Panel alternate); Jennifer Casselle, Marine Science Institute, UCSB (Panel); John Colgate, commercial diver, DAAC, RAAC, and Panel member; Jim Curland, Defenders of Wildlife (Panel); Rocky Daniels, recreational diver, RAAC member (Panel alternate); Tom Ebert, Emeritus professor, SDSU (Panel); Carolyn Friedman, University of Washington (Panel); Leah Gerber, National Center for Ecological Analysis and Synthesis (Panel alternate); Michael Henderson, recreational diver, RAAC member; Konstantin Karpov, CDFG, RAAC member (Chair); Harry Liquornik, commercial diver (alternate), DAAC; Jim Marshall, commercial diver, DAAC; Tom McCormick, Proteus Sea Farms and Channel Islands Marine Research Institute (Panel); Richard Pogre, commercial diver, RAAC member; Steve Schroeder, Marine Science Institute, UCSB (Panel); Steve Riske, CDFG warden, RAAC member; Greg Sanders, U.S. Fish and Wildlife Service (Panel); and Kate Wing, Natural Resources Defense Council (Panel).

Others always made themselves available for information and suggestions. We thank them for their help and look forward to working with them in the future. They are (in alphabetical order): Mary Bergen, CDFG; Paul Dayton, Scripps Institution of Oceanography; Alistair Hobday, CSIRO Marine Research, Tasmania, Australia; Eric Knaggs, CDFG; Kristin Riser, Scripps Institution of Oceanography; L. Ignacio Vilchis, Scripps Institution of Oceanography; and Fred Wendell, CDFG.

We also thank all the individuals who took the time to participate and comment at the various public meetings and workshops during the preparation of the ARMP.

List of Preparers

Allen, Brian. Scientific Aide. CDFG. Bodega Bay, CA

Callaway, Marisa. Scientific Aide. CDFG. Fort Bragg, CA

Haaker, Peter. Senior Biologist. CDFG. Los Alamitos, CA

Kalvass, Peter. Associate Marine Biologist. CDFG. Fort Bragg, CA

Karpov, Konstantin. Senior Biologist. CDFG. Fort Bragg, CA

Kashiwada, Jerry. Marine Biologist. CDFG. Fort Bragg, CA

Lauermann, Andrew. Scientific Aide. CDFG. Eureka, CA

Patyten, Mary. Research Writer. CDFG. Monterey, CA

O'Leary, Jennifer. Marine Biologist. CDFG. Fort Bragg, CA

O'Reilly, Kelly. Marine Biologist. CDFG. Los Alamitos, CA

Ramsay, Jonathan. Marine Biologist. CDFG. Eureka, CA

Rogers-Bennett, Laura. Associate Marine Biologist. CDFG. Bodega Bay, CA

Skeen, Christa. Scientific Aide. CDFG. Fort Bragg, CA

Taniguchi, Ian. Associate Marine Biologist. CDFG. Los Alamitos, CA

Watters, Diana. Associate Marine Biologist. CDFG. Belmont, CA

Wine, Vickie. Associate Marine Biologist. CDFG. Los Alamitos, CA